



Journal Homepage: -[www.journalijar.com](http://www.journalijar.com)  
**INTERNATIONAL JOURNAL OF  
 ADVANCED RESEARCH (IJAR)**

Article DOI:10.21474/IJAR01/6980  
 DOI URL: <http://dx.doi.org/10.21474/IJAR01/6980>



### RESEARCH ARTICLE

#### OPTIMIZATION OF PRODUCTION PROCESS OF SOYA OIL.

Sanjay goyal<sup>1</sup> and Prashant Kushwah<sup>2</sup>.

- 1 Assistant Professor Mechanical Engineering Department, MPCT, Gwalior (M.P), IND.
- 2 M.Tech Research Scholar MPCT Gwalior (M.P), INDIA.

#### Manuscript Info

##### Manuscript History

Received: 18 February 2018  
 Final Accepted: 20 March 2018  
 Published: April 2018

##### Keywords:-

Soya beans , solvent, flake, Taguchi,  
 Orthogonal Array, S/N Ratio.

#### Abstract

Modern processing plants extract soya beans oil by solvent liquid transfer. Soya beans are cleaned, cracked, de hulled and conditioned into a thin flake before they enter the extractor. Extraction is by successive, counter current washes with hexane solvent. The extracted flakes are then carried by a sealed conveyor to be de solvent in enclosed vessels by application of jacket and spurge steam. Hexane is removed from the oil in rising film evaporators and with final vacuum distillation. Hexane is recovered from the meal and the oil in atmospheric condensers. Parameters of the process in the plant are no. of part of seed, thickness of flake and weight of solvent per ton of soya beans. Oil quality is measured in terms of free fatty acids, absence of residual hexane and crude oil.

Copy Right, IJAR, 2018,. All rights reserved.

#### Introduction:-

Taguchi is a methodology which gives the optimum combination of independent parameter which has a significant role to change the value of dependent parameter. The prime objective of the method is to design best quality product at least cost of manufacturer. This method was generated by Dr. Genichi Taguchi of Japan .This method has designed to investigate how various parameters significantly affect the mean and variance of parameter pertaining to main characteristic and quality of process .The orthogonal arrays is the prime tool which arrays to organize the parameters affecting the process and the levels at which they should be varies. Taguchi method tests pairs of combinations in place of all possible combinations .This provide the necessary data to identify the significance of factors affecting product quality with a minimum recourses and time. The arrays are selected on the basis of degree of freedom of parameter which depends on the no of parameter and their level. The data from the arrays can be analyzed by visual analysis.

#### Taguchi Technique:-

This technique is completely based on statistical concepts and. Many renowned firms have achieved great success by applying this methods. Taguchi method adopted experimentally to investigate influence of parameters such as no of pieces of soya seeds , thickness of flake , and weight of solvent per ton of soya seeds.The Taguchi process helps to select or to determine the optimum combination of these parameters on production of oil . Many researchers developed many mathematical models to optimize these parameters to get maximum production of oil.

#### Philosophy of the Taguchi Method:-

Quality of product depends on the process by which it has been produced. One can improve the quality by optimising the parameter which affects the process.

**Corresponding Author:- Sanjay goyal.**

Address:- Assistant Professor Mechanical Engineering Department, MPCT , Gwalior (M.P), IND.

1. Best quality can be achieved by minimizing uncontrollable environmental factor which leads to deviation from a target.
2. The cost of quality should be measured as a function of deviation from the standard and the losses should be measured system wide.

### Procedure and Steps:-

#### Step-1:-Selection of the quality characteristic

There are three types of quality characteristics in the Taguchi methodology, such as **smaller-the-better, larger the-better, and nominal-the-best**. For example, smaller-the-better is considered when measuring fuel consumption of fuel in automobile or roughness in surface finish. The goal of this research was to find the effect of parameters and achieve maximum production of soya oil

#### Step-2:-Selection of noise factors and control factors

Selected controllable factors are no of pieces (N), Thickness of flake (T) and Weight of solvent (W). Since these factors are controllable so they are considered as controllable factors in the study. Uncontrollable factor may be the ambient temperature and Humidity

#### Step-3:-Selection of Orthogonal Array

There are 9 basic types of standard Orthogonal Arrays (OA) in the Taguchi parameter design. Selection of arrays depends on the degree of freedom of selected parameter. Degree of freedom of all three parameter is 6. An L<sub>9</sub> Orthogonal Array is selected for this work. The layout of this L<sub>9</sub> OA is as mentioned in Table 1

Experiment	P1	P2	P3
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

**Table 1:-**L<sub>9</sub> Orthogonal Array

#### Step-4:-Conducting the experiments

Table illustrates the experimental settings in this study for maximum production of oil. The parameters used in this experiment are no of pieces, Thickness of flake, and Weight of solvent.

#### Step-5:-Predicting Optimum Performance

Using the mentioned data, one could predict the optimum combination of parameter. With this prediction, one could conclude that which combination will create the better result.

#### Step-6:-Establishing the design by using a confirmation experiment

The confirmation experiment helps to verify our prediction particularly when small fractional factorial experiments are utilized.

### Selection Of Ranges & Levels Of Process Variables:-

As the literature suggested, the quality and quantity of oil product depends upon various factors and their levels are chosen, which are following

- 1 Quality of seeds
- 2 Size of pieces
- 3 Thickness of flake
- 4 Quantity of solvent

The factor that considerably contributes to  
The quality and quantity of soya oil are selected.  
No. of pieces (N)

L = Lower Level = 4  
M = Medium Level = 6  
H = High Level = 8

Thickness of flake (T)

L = 0.28 mm  
M = 0.3 mm  
H = 0.32 mm

Solvent Per ton of soya seed (W)

L = 1.5 ton  
M = 2.0 ton  
H = 2.5 ton

### Experimental Results:-

S.N	N	T (mm)	W (ton)	Oil production (Liter/ton)			Product (Liter)
				I	II	III	
1	4	0.28	1.5	16.5	16.8	16.7	16.70
2	4	0.30	2.0	18.5	18.7	18.9	18.70
3	4	0.32	2.5	17.6	17.5	17.8	17.63
4	6	0.28	2.0	15.7	16.3	16.0	16.00
5	6	0.30	2.5	16.7	17.3	17.0	17.00
6	6	0.32	1.5	15.7	15.8	15.9	15.80
7	8	0.28	2.5	14.4	14.5	14.7	14.53
8	8	0.30	1.5	15.2	15.4	15.3	15.33
9	8	0.32	2.0	15.4	15.4	15.5	15.45

**Table 2:-**Experimental Result

### Signal to Noise Ratio or S/N Ratio:-

The response variable considered in this study is Production, which is of larger the better kind. Therefore, signal to noise ratio is defined by

$$S/N \text{ RATIO } (H_i) = -10 \text{ Log}_{10} [(1/n) * \sum_i (1/ Y_i^2)]$$

Where,  $Y_i$  are the individual measurement production in liter per ton of soya seeds

S.N0	Exp1	Exp2	Exp3	MSD	S/N Ratio
1	16.5	16.8	16.7	0.0036	2.4436
2	18.5	18.7	18.9	0.0028	2.5528
3	17.63	17.5	17.8	0.0032	2.4948
4	15.7	16.3	16.0	0.0039	2.4089
5	16.7	17.3	17.0	0.0034	2.4685
6	15.7	15.8	15.9	0.0040	2.3972
7	14.4	14.5	14.7	0.0047	2.3279
8	15.2	15.4	15.3	0.0042	2.3767
9	15.4	15.45	15.5	0.0041	2.3872

**Table 3:-**Signal to noise ratio

### Mean Production & S/N Ratio Summary Sheet:-

Symbol	Controllable Factors	Level I	Level II	Level III
N	No of Soya Pieces	2.49	2.41	2.35
T	Flake Thickness	2.38	2.46	2.42

<b>W</b>	<b>Solvent Volume</b>	2.40	<b>2.443</b>	2.42
----------	-----------------------	------	--------------	------

**Table 4:-**Optimum Signal to noise ratio

**Analysis Of Mean:-**

The mean effect of No. of pieces at various level is calculated as follows:

$$N_1 = (16.66+18.70+17.63)/3 = 17.66 \text{ lit}$$

Similarly,

$$N_2 = (16.0+17.0+15.80)/3 = 16.26 \text{ Lit}$$

$$N_3 = (14.53+15.33+15.45)/3 = 15.10 \text{ Lit}$$

The main effect of thickness of flake various levels are calculated as:

$$T_1 = (16.66+16.0+14.53)/3 = 15.73 \text{ Lit}$$

Similarly,

$$T_2 = (18.70+17.0+15.33)/3 = 17.01 \text{ Lit}$$

$$T_3 = (17.63+15.8+15.45)/3 = 16.29 \text{ Lit}$$

The main effect of weight of solvent at various levels are calculated as:

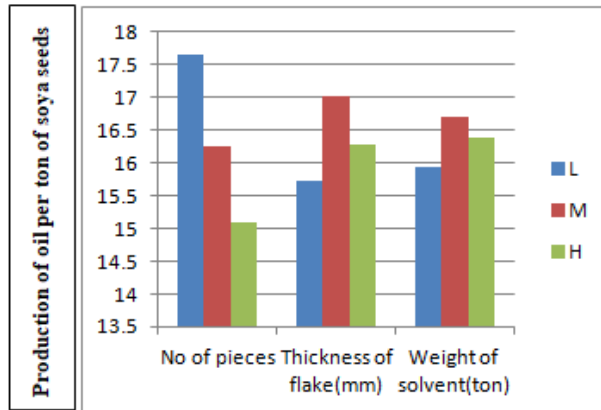
$$W_1 = (16.66+15.8+15.33)/3 = 15.93 \text{ Lit}$$

Similarly,

$$W_2 = (18.70+16.0+15.45)/3 = 16.716 \text{ Lit}$$

$$W_3 = (17.63+17.00+14.53)/3 = 16.386 \text{ Lit}$$

Symbol	Controllable Factors	Level I	Level II	Level III
<b>N</b>	<b>No of Soya Pieces</b>	<b>17.66</b>	16.26	15.10
<b>T</b>	<b>Flex Thickness</b>	15.73	<b>17.01</b>	16.29
<b>W</b>	<b>Solvent Weight</b>	15.93	<b>16.71</b>	16.38



**Graph 1:-**Effect of parameter on production

**Mathematical Modeling:-**

X=[1 1.3863 -1.2729 .4054; 1 1.3863 -1.2039 0.6931; 1 1.3863 -1.1394 0.9162; 1 1.7917 -1.2729 0.6931; 1 1.7917 -1.2039 0.9162; 1 1.7917 -1.1394 0.4054; 1 2.0795 -1.2729 0.9162; 1 2.0795 -1.2039 0.4054; 1 2.0795 -1.1394 0.6931]

X =

1.0000	1.3863	-1.2729	0.4054
1.0000	1.3863	-1.2039	0.6931
1.0000	1.3863	-1.1394	0.9162
1.0000	1.7917	-1.2729	0.6931
1.0000	1.7917	-1.2039	0.9162
1.0000	1.7917	-1.1394	0.4054

1.0000 2.0795 -1.2729 0.9162  
 1.0000 2.0795 -1.2039 0.4054  
 1.0000 2.0795 -1.1394 0.6931

Y=[2.8154;2.9285;2.8696;2.7725;2.8332;2.7600;2.6762;2.7298;2.7376]

Y =

2.8154  
 2.9285  
 2.8696  
 2.7725  
 2.8332  
 2.7600  
 2.6762  
 2.7298  
 2.7376

X'

ans =

1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00  
 1.38 1.38 1.38 1.79 1.79 1.79 2.07 2.07 2.07  
 -1.27 -1.20 -1.13 -1.27 -1.20 -1.13 -1.27 -1.20 -1.13  
 0.40 0.69 0.91 0.69 0.91 0.40 0.91 0.40 0.69  
 X\*X

ans =

9.0000 15.7725 -10.8486 6.0441  
 15.7725 28.3690 -19.0122 10.5923  
 -10.8486 -19.0122 13.1036 -7.2856  
 6.0441 10.5923 -7.2856 4.4525

inv(X\*X)

ans =

59.8084 -2.4083 45.0726 -1.7068  
 -2.4083 1.3742 0.0000 -0.0000  
 45.0726 0.0000 37.3923 0.0000  
 -1.7068 -0.0000 0.0000 2.5415

A=ans

A =

59.8084 -2.4083 45.0726 -1.7068  
 -2.4083 1.3742 0.0000 -0.0000  
 45.0726 0.0000 37.3923 0.0000  
 -1.7068 -0.0000 0.0000 2.5415

B=X\*Y

B =

25.1228  
 43.8643  
 -30.2759  
 16.8926

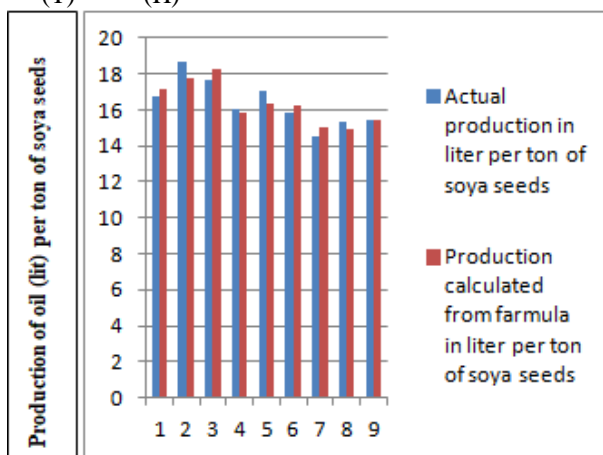
A\*B

ans =

3.4712  
-0.2245  
0.2672  
0.0532

$C_0 = \text{Antilog } 3.4712$   
= 32.1753  
 $C_1 = -0.2245$   
 $C_2 = 0.2672$   
 $C_3 = 0.0532$

Production =  $32.1753 * (N)^{-0.2245} * (T)^{0.2672} * (H)^{0.0532}$



### Conclusion:-

The research article an application of Taguchi method for optimizing the parameters and indicates that the Taguchi design of experiment is an effective way of determining the optimal combination of parameter for maximum production of oil in liter per ton of soya seeds. The outcome of the calculation and formulation for the optimization by Taguchi method, is that With 4 no of pieces of soya seeds having 0.3mm thickness of flake give the maximum production if the solvent is just double in weight of soya seeds.

### Reference:-

- 1 R. A. Carr, "Degumming and refining practices in the U.S.," *Journal of the American Oil Chemists' Society*, vol. 53, pp. 347–352, 1976.
- 2 V. Kale, S. P. R. Katikaneni, and M. Cheryan, "Deacidifying rice bran oil by solvent extraction and membrane technology," *Journal of the American Oil Chemists' Society*, vol. 76, no. 6, pp.723–727, 1999.
- 3 S. S. Koseoglu, "Membrane technology for edible oil refining," *Oils & Fats International*, vol. 5, pp. 16–21, 1991.
- 4 R. Subramanian, M. Nakajima, K. S. M. S. Raghavarao, and T. Kimura, "Processing vegetable oils using nonporous denser polymeric composite membranes," *Journal of the American Oil Chemists' Society*, vol. 81, no. 4, pp. 313–322, 2004.
- 5 M. Cheryan, *Ultrafiltration Handbook*, Technomic Publishing, Lancaster, Pa, USA, 1986.
- 6 J. B. Snape and M. Nakajima, "Processing of agricultural fats and oils using membrane technology," *Journal of Food Engineering*, vol. 30, no. 1-2, pp. 1–41, 1996.
- 7 L. P. Raman, N. Rajagopaln, and M. Cheryan, "Membrane technology," *Oils & Fats International*, vol. 6, no. 10, pp. 28–39, 1994
- 8 F. Cuperus and J. Derksen, "Applications of membrane technology in the processing of vegetable oils and derivatives," *Lipid Technology*, pp. 101–107, 1995.

- 9 C. Pagliero, N. Ochoa, J. Marchese, and M. Mattea, "Vegetable oil degumming with polyimide and polyvinylidene fluoride ultrafiltration membranes," *Journal of Chemical Technology and Biotechnology*, vol. 79, no. 2, pp. 148–152, 2004.
- 10 C. Pagliero, M. Mattea, N. Ochoa, and J. Marchese, "Fouling of polymeric membranes during degumming of crude sunflower and soybean oil," *Journal of Food Engineering*, vol. 78, no. 1, pp. 194–197, 2007
- 11 C. de Morais Coutinho, M. C. Chiu, R. C. Basso, A. P. B. Ribeiro, L. A. G. Gonçalves, and L. A. Viotto, "State of art of the application of membrane technology to vegetable oils: a review," *Food Research International*, vol. 42, no. 5-6, pp. 536–550, 2009.
- 12 A. R. Ladhe and N. S. Krishna Kumar, "Application of membrane technology in vegetable oil processing," in *Membrane Technology*, pp. 63–78, 2010.
- 13 M. de Souza Araki, C. de Morais Coutinho, L. A. G. Gonçalves, and L. A. Viotto, "Solvent permeability in commercial ultrafiltration polymeric membranes and evaluation of the structural and chemical stability towards hexane," *Separation and Purification Technology*, vol. 71, no. 1, pp. 13–21, 2010
- 14 A. Moustafa, "Producción de aceite de soja de alta calidad," *Grasas y Aceites*, vol. 46, pp. 366–368, 1995.
- 15 L. P. Raman, M. Cheryan, and N. Rajagopalan, "Deacidification of soybean oil by membrane technology," *Journal of the American Oil Chemists' Society*, vol. 73, no. 2, pp. 219–224, 1996.